REMARKS/ARGUMENTS

Claims 1-23 are pending in the instant application. Claims 1-23 stand rejected. Claims 1, 2, 5-13, and 16-23 stand rejected under 35 U.S.C. §102(a) as being unpatentable over United States Patent No. 6,008,493 to Shao et al. in view of the article by Badawi et al. in Phy. Med. Biol. 43 (1998) pg 189-205. Claims 3, 4, 14, and 15 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Shao and Badawi in view of United States Patent No. 6,198,104 to Gregan. Claims 7 and 8 have been amended to more clearly define the invention. Applicants respectfully submit that none of the amendments constitute new matter in contravention of 35 U.S.C. §132. Reconsideration is respectfully requested.

Claims 1, 2, 5-13, and 16-23 stand rejected under 35 U.S.C. §102(a) as being unpatentable over United States Patent No. 6,008,493 to Shao et al. in view of the article by Badawi et al. in Phy. Med. Biol. 43 (1998) pg 189-205. This rejection is respectfully traversed.

The Examiner cites Shao for disclosing a method of generating detector efficiency data for a PET scanner. Badawi is cited for teaching an efficiency estimation algorithm to calculate data representative of the efficiencies of the detectors in the array, thus correcting the deficiency of Shao.

Applicants respectfully submit that the Examiner has failed to meet his burden to establish a prima facie case of obviousness. While Shao refers to a single photon source, it does not refer to detector efficiencies. Moreover, Badawi is not directed to systems using a single photon source, but to positron emission sources. As a result the efficiency estimation algorithm of Badawi would not correct the deficiencies of Shao.

In support of this conclusion, Applicants note that while Badawi et al does not talk explicitly about a positron source, the paper refers to Hoffman IEEE Trans Nucl Sc 1989. This paper initially again does not talk explicitly about a positron source, but its Figure 1 makes clear that the measurement uses lines through the (plane) source, which is only true for a "PET-type" measurement (i.e. coincidence of 2 gamma photons from the positron-electron annihilation). Furthermore, on p. 1111, first column line 9 the Hoffman paper says "A logical extension of this normalization technique can be performed with a symmetric source, such as a uniform cylinder of positron emitter, ...".

Badawi et al published a follow-up paper in Phys. Med. Biol. 1999 "Developments in component-based normalization for 3D PET" which uses essentially the same equation as eq. 1 in Badawi PMB 1998. In the PMB1999 paper, Badawi et al say at the start of section 2.1

> **"The activity within an LOR in a PET study is given by the following expression Auivj = (C(prompt)uivj –**

> **C(random)uivj – C(scatter)uivj) *NC(true)uivj attuivj dtuivj (1)"**

where NC are the Normalisation Coefficients that they try to estimate. So, here, Badawi et al say that their model applies to "a PET study", i.e. a coincidence measurement.

Additionally, Badawi et al PMB 1999 refer to Casey M E, Gadagkar H and Newport D [1995 A component based method for normalisation in volume PET, Proc. 3rd Int. Meeting on Fully Three-Dimensional Image Reconstruction in Radiology and Nuclear Medicine (Aix-les-Bains, France) pp 67–71] for the component based normalisation which forms the basis for Badawi's eq. 1 (and also eq. 1 recited in the instant application). The Casey paper says in the section "Components of Normalization" :

> **"... The detection of positron annihilations complicates the issue by requiring that two gamma rays be detected simultaneously. Considering these effects, the ability of a detector pair to detect an annihilation on its line-of-response (LOR) is proportional to the product of the average detection efficiencies of the individual detectors ..."**

and then gives their eq. 1 which is identical to eq. 1 of the instant application (albeit using different symbols).

Applicants respectfully submit that it is clear that Badawi et al disclose a method for deriving efficiencies (and other normalisation factor) from data from a positron source.

Thus, Badawi is related to using a positron emission source, rather than using a single photon source as claimed by the present invention. This crucial distinction affects how the acquisition works, and how it is modeled when doing the estimation. Using the wrong model for a single photon source, such as the Badawi model, results in incorrect estimates. Additionally, using the Badawi model would fail to provide correct estimates for a single photon source.

The cited art provides the model for a blank scan using a positron emitter in eq (1). This model (which is well-known and is related to the model used by Badawi) is based on the use of a rotating positron source. The source emits a positron, which annihilates with a (nearby) electron, resulting in emission of 2 gamma photons. These 2 gamma photons are each detected by separate detectors. The count is stored in a sinogram-bin corresponding to the line between those 2 detectors. The total probability of detection of both photons is given by eq. 1, which essentially says that it is proportional to the <u>multiple</u> of the 2 efficiencies. For example, if 1 detector would fail (i.e. have efficiency $\varepsilon_i = 0$), then the probability for detection of the photon pair is 0.

The present invention, in contrast to the cited art, provides a model for a blank scan using a single photon emitter such as given in eqs 4 and 9. As the measurement of a single photon involves only one detector, the detection model

will not contain the multiple of 2 efficiencies as in Badawi. Moreover, in the embodiment cited in claim 4 hereinabove, this is an additive model. The additive model is based on the fact that the measurement uses a rotating single photon point source and tracks its position. Photons are detected in detectors at "the other side" (i.e. the source is at one side of the scanner, the detector is at the other). The count is stored in a sinogram-bin corresponding to the line between those the source and the detector (in a procedure akin to Gregan et al as cited by the examiner). The probability for this detection is proportional to the efficiency of that detector. However, because the source rotates, at a later time-point, the source will be at the other side of the scanner, and there might be a detection for the same line – <u>but</u> it now was via a detector which was at the other side of the line. Therefore, the total counts in the sinogram-bin will follow the model given in eq. 4. Additionally, Eq. 9 is a simplified version of eq. 4 for the case that the measurement is not the sum of multiple positions of the single photon point source with respect to the detectors. In any case, it is clear that both eqs. 4 and 9 are different from Badawi's model (i.e. eq. 1).

The Badawi paper cited by the examiner is about the first case, i.e. using a positron emitter as source, and therefore rely on the model according to eq. 1. Applying the model of eq. 1 to a measurement acquired with a single photon source would generate a wrong estimate for the efficiencies. For example, with a detector out, the eq. 1 model predicts that the counts in all sinogram bins that 'use'

that detector will have zero counts. However, for that same case, the eq. 4 model says that those bins will not be 0, but will be roughly half of what they would be with a working detector. Therefore, using model 1 will never alert one that the detector is out.

Thus, as Badawi does not disclose, teach, or suggest the use of a single photon source, this reference cannot correct the deficiencies of the other references. Moreover, as neither Badawi nor Shao disclose a suitable method for determining detector efficiency for a single photon source, Applicants respectfully submit that the present invention is patentably distinct thereover. Reconsideration and withdrawal of the rejection are respectfully requested.

Claims 3, 4, 14, and 15 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Shao and Badawi in view of United States Patent No. 6,198,104 to Gregan. This rejection is respectfully traversed.

Applicants respectfully submit that as claims 2, 4, 14, and 15 each depend from an allowable independent claim, it is axiomatic that each is likewise allowable. Reconsideration and withdrawal of the rejection are respectfully requested.

In view of the amendments and remarks hereinabove, Applicants respectfully submit that the instant application, including claims 1-23, is in condition for allowance. Favorable action thereon is respectfully requested.

Any questions with respect to the foregoing may be directed to Applicants' undersigned counsel at the telephone number below.

Respectfully submitted,

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